(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number : **0 437 037 B1**

(12) **EUROPEAN PATENT SPECIFICATION**

(45) Date of publication of patent specification : **09.03.94 Bulletin 94/10**

(51) Int. Cl.[5] : **H05B 7/12**

(21) Application number : **90313013.6**

(22) Date of filing : **29.11.90**

(54) **Method and apparatus for closing the gap between an electrode and its furnace cover in an electric furnace.**

(30) Priority : **11.12.89 DE 3940848**

(43) Date of publication of application : **17.07.91 Bulletin 91/29**

(45) Publication of the grant of the patent : **09.03.94 Bulletin 94/10**

(84) Designated Contracting States : **DE FR GB IT SE**

(56) References cited :
EP-A- 0 309 583
DE-A- 1 167 992
FR-A- 466 265
GB-A- 2 114 408
US-A- 3 697 660

(73) Proprietor : **FOSECO INTERNATIONAL LIMITED**
285 Long Acre
Nechells Birmingham B7 5JR (GB)

(72) Inventor : **Comes, Heinrich**
Boomkamp 20
W-3-Weseke (DE)
Inventor : **Wolf, Josef**
Zillestrasse 6
W-4130 Moers (DE)

(74) Representative : **Eyles, Winifred Joyce**
Foseco International Limited 285 Long Acre
Nechells
Birmingham B7 5JR (GB)

EP 0 437 037 B1

Description

The invention relates to a method for closing the gap between a graphite electrode and a through-hole for the electrode formed in the furnace cover of an electric furnace by means of a cooling packing ring made of refractory material and relates also to an apparatus for performing this method.

When preparing steel according to the arc furnace process, electric energy is transferred by graphite electrodes to the material to be melted. The top of the accompanying furnace vessel is closed by a cover, which is provided with openings for the passing of the electrodes, which openings, for reasons of operational safety, are larger than the electrodes. Through these gaps, however, hot gas escapes in the course of the fusion process, which contaminates and damages the upper structure of the furnace and furthermore, this loads the furnace hall with dust. Moreover, local heating of the graphite electrodes occurs, inducing additional loss by non-uniform burning off.

In order to minimise this loss which has nothing to do with the actual fusion process, so-called coated electrodes have been used, in which the graphite on the surface is protected by a coat of aluminium compositions and boric acid respectively, containing refractory components. These coating methods, however, are too uneconomical today.

It is also known to spray water onto the graphite surfaces above the passage through the cover into the interior of the electric furnace. With this a certain cooling effect can be achieved, which, on the one hand originates from the temperature rise of the water and partly from the evaporation heat of the water. However, this cooling effect takes place above the passage or the sealing place, respectively, without a specific effect occurring with regard to cooling or sealing on the sealing region.

In a known apparatus of the initially mentioned kind (European Patent Publication No. 0080335) gas is inserted in substantially tangential direction into a ring- and spiral-shaped chamber which is open towards the electrode. However, the cooling effect achieved with this is - just like the sealing effect of the known apparatus - varying in strength over the circumference, with the result of a locally insufficient sealing and larger burning off of the electrodes.

In a further known apparatus of the initially mentioned kind, (U.S. Patent No. 3697660) two half rings are provided which surround the electrode in spaced relation. Each of said half rings is provided at its radial inside with a plurality of uniformly distributed openings, through which inert gas escapes which was introduced into the half ring. At both sides of the outlet openings there are blades running in radial-tangential direction in order to produce a gas flow around the surface of the electrode. With this an equalisation of both the cooling effect and the sealing effect can be achieved, due to the oncoming flow of gases. However, no optimal cooling and sealing effect can be achieved.

The invention is based on the problem to develop a method and an apparatus of the initially mentioned kind in a manner that on the one hand there is achieved a sealing effect uniformly distributed over the circumference, but on the other hand there is also possible an optimal cooling of the surface of the electrode.

Accordingly, in a first aspect the invention provides a method of sealing the gap between a graphite electrode and a through hole for the electrode formed in the cover on an electric furnace using a cooling sealing ring of refractory material, in which a gas-fluid mixture is fed to the gap via a plurality of conduits in the cooling sealing ring, the conduits being uniformly distributed around the circumference of the sealing ring and extending in a direction having both a radial and a tangential component together with an axial inclination relative to the longitudinal axis of the electrode, whereby the gas-fluid mixture acts as a seal and the fluid absorbs heat from the region inside the cooling sealing ring by endothermic reaction, vaporisation and/or cracking to form graphite or petroleum coke.

The axial inclination of the conduits is preferably towards the tip of the electrode.

In a second aspect the invention provides an apparatus for sealing the gap between a graphite electrode and a through hole for the electrode formed in the cover of an electric furnace which comprises a cooling sealing ring of refractory material, the cooling sealing ring having a plurality of conduits uniformly distributed around its circumference and opening into the gap, the conduits extending through the sealing cooling ring in a direction having both a radial and a tangential component together with an axial inclination relative to the longitudinal axis of the electrode.

The angle of axial inclination of the conduits is preferably up to 30°, especially 5° to 20°. The angle of the conduits from the tangential at the exterior circumference of the sealing ring is preferably from 10° to 170°.

Thus, an essential feature of the invention is the mixed tangential-radial-axial oncoming flow of the gases onto the surface of the electrode, the vector of the gas-fluid-mixture flowing onto the surface having components not equal to zero in all three cylinder coordinates. By this means it is at first achieved that the cooling gases reach the hot surface, cool this by self-heating and the heated gases seal the gap, thus inhibiting the escape of furnace gases.

In the present invention, however, there still exists another effect of particular importance, particularly an endothermic effect. By using a gas-liquid-mixture of a certain composition, it can be achieved that this mixture or the fluid component vaporises in

the area of the sealing means. For this vaporisation step a specific energy is necessary which is taken from the environment, which means that in the sealing area the electrode is cooled down to an extraordinary extent. Due to the transition of the fluid component of the mixture into the gas form there also occurs an increased sealing effect, so that in the sealing region one could speak of a kind of sealing ring of gaseous material. These two effects only occur with the apparatus according to the invention, so that in this context a cooling sealing ring may correctly be referred to, whereas in the state of the art there merely existed sealing rings with a certain cooling.

It is also within the scope of the present invention to select a very specific composition of the gas-fluid-mixture. When using e.g. an oil, this oil will reach the graphite surface of the electrode via the flow of the gas. Due to the existing temperatures the oil cracks and the energy required for this step is again withdrawn from the environment of the sealing area, which leads to an additional cooling effect. As a result of this cracking step a coating of graphite or petroleum coke is provided at the surface of the graphite electrode and this coating furthermore forms a protection of the electrode and aids a uniform consumption of the electrode in the circumferential direction.

In the sense of the present invention a gas-fluid-mixture is to be understood to be a composition of individual gases and liquids but may also include powder particles, but also mixtures (also in form of emulsions or dispersion), which causes the effect of temperature reduction by changing the aggregate state (vaporisation, cracking, other changes in state) as well as a coating of the surface of the electrode and a reduction of the width of the gap.

In the following the invention is explained by way of example with reference to the drawing.

Figure 1 shows a top view of an apparatus according to the invention with the individual feed conduits for the gas-fluid-mixture.

Figure 2 shows a cross-sectional view through one of the feed conduits.

In Figure 1, electrode 10 has a gap 11 surrounding the electrode, the gap being defined between the electrode and a concentric cooling sealing ring 15. In the cooling sealing ring 15 there is provided a plurality (in the drawing there are shown eight thereof) of oblique bores 1 (shown at tangential angle β) each of which opens into gap 11 via an opening 13 and which serve as feed conduits. Conduit 1 is supplied by a ring conduit 12 which is either positioned in the cooling sealing ring 15 or on the outside of this cooling sealing ring and which in turn is supplied with a gas-fluid-mixture via a feed connection 20.

From Figure 2 there is evident the slight axial inclination (angle α)of the individual conduits 1. Openings 13 may be of part-circular,-axial or angular, e.g. wedge-shaped form.

Gases, e.g. air, steam, natural gas, coke oven or water gas, nitrogen, carbon monoxide and carbon dioxide or the like, with fluid media, e.g. water, oils, fats, tars, highly volatile coals (lignites, open-burning or gas flame coals), alcohol or the like, may be supplied through the conduits. In a preferred embodiment those fluids are used which are composed such that they withdraw from this region additional heat by vaporisation when entering the gap or when touching the electrode surface, so that an increased cooling effect occurs.

The outside of the cooling sealing ring may be provided with a type of sheet cover, which may be cylindrical as well as profiled, wherein e.g. a concave opening of the profile can simultaneously serve as a central supply channel.

Claims

1. A method of sealing the gap between a graphite electrode and a through-hole for said electrode formed in the furnace cover of an electric furnace using a cooling sealing ring made of refractory material, characterised in that a gas-fluid-mixture is fed to the gap (11) via a plurality of conduits (1) in the cooling sealing ring (15) the conduits (1) being uniformly distributed around the circumference of the sealing ring (15) and extending in a direction having both a radial and a tangential component together with an axial inclination relative to the longitudinal axis of the electrode (10), whereby the gas-fluid-mixture acts as a seal and the fluid absorbs heat from the region inside the cooling sealing ring (15) by endothermic actions, by vaporisation and/or by cracking.

2. A method according to Claim 1, characterised in that the fluid is an oil, fat, tar, water or alcohol.

3. A method according to Claim 1 or 2, characterised in that the gas is air, steam, natural gas, coke oven or water gas, nitrogen, carbon monoxide or carbon dioxide.

4. A method according to Claim 1, 2, or 3, characterised in that the gas-fluid-mixture additionally contains powder particles.

5. A method according to Claim 4, characterised in that the powder particles are volatile coals, e.g. lignite or open-burning coals.

6. An apparatus for sealing the gap between a graphite electrode and a through-hole for the electrode formed in the cover of an electric furnace which comprises a cooling sealing ring made of refractory material, characterised in that

in the cooling sealing ring (15) has a plurality of conduits (1) which are uniformly distributed around its circumference and opening into the gap (11), which conduits (1) extend through the sealing cooling ring (15) in a direction having both a radial and a tangential component together with an axial inclination relative to the longitudinal axis of the electrode (10).

7. An apparatus according to Claim 6, characterised in that the angle of axial inclination of the conduits (1) is from 1° to 30°.

8. An apparatus according to Claim 7, characterised in that the angle of axial inclination of conduits (1) is from 5° to 20°.

9. An apparatus according to Claim 6, 7 or 8, characterised in that the axial inclination of the conduits (1) is towards the tip to the electrode (10).

10. An apparatus according to Claim 6, 7, 8, or 9, characterised in that the angle of the conduits (1) from the tangential at the exterior circumference of the sealing ring (15) is from 10° to 170°.

11. An apparatus according to any one of Claims 6 to 10, characterised in that the conduits (1) are connected to a ring conduit (12) which is inside or on the outside periphery of cooling sealing ring (15).

12. An apparatus according to any one of Claims 6 to 11, characterised in that the conduits feed into the gap (11) via openings (13) of part-circular or oval or angular form.

Patentansprüche

1. Verfahren zum Schließen des Spalts zwischen einer Graphitelektrode und einem für diese in der Ofendecke eines Elektroofens gebildeten Durchgang unter Verwendung eines kühlenden Dichtungsrings aus feuerfestem Werkstoff, dadurch gekennzeichnet, daß man ein Gas/Flüssigkeitsgemisch durch mehrere Leitungen (1) im kühlenden Dichtungsring (15) in den Spalt (11) einführt, wobei die Leitungen (1) gleichmäßig um den Umfang des Dichtungsrings (15) herum angeordnet sind und sich in einer Richtung mit sowohl einer radialen als auch einer tangentialen Komponente zusammen mit einer axialen Neigung zur Längsachse der Elektrode (10) erstrecken, wodurch das Gas/Flüssigkeitsgemisch als Dichtung wirkt und die Flüssigkeit durch endotherme Wirkungen, durch Verdampfung und/oder Spaltung Wärme aus dem Bereich innerhalb des kühlenden Dichtungrings (15) aufnimmt.

2. Verfahren nach Anspruch 1, dadurch gekennzeichnet, daß die Flüssigkeit ein Öl, Fett, Teer, Wasser oder Alkohol ist.

3. Verfahren nach Anspruch 1 oder 2, dadurch gekennzeichnet, daß das Gas Luft, Dampf, Erdgas, Koksofen- oder Wassergas, Stickstoff, Kohlenmonoxid oder Kohlendioxid ist.

4. Verfahren nach Anspruch 1, 2 oder 3, dadurch gekennzeichnet, daß das Gas/Flüssigkeitsgemisch zusätzlich Pulverteilchen enthält.

5. Verfahren nach Anspruch 4, dadurch gekennzeichnet, daß die Pulverteilchen flüchtige Kohlen, z.B. Braunkohle oder offenbrennende Kohlen, sind.

6. Vorrichtung zum Schließen des Spalts zwischen einer Graphitelektrode und einem für diese in der Decke eines Elektroofens gebildeten Durchgang, umfassend einen kühlenden Dichtungsring aus feuerfestem Werkstoff, dadurch gekennzeichnet, daß der kühlende Dichtungsring (15) mehrere gleichförmig um dessen Umfang herum verteilte und in den Spalt (11) mündende Leitungen (1) aufweist, welche sich durch den dichtenden Kühlring (15) in einer Richtung mit sowohl einer radialen als auch einer tangentialen Komponente zusammen mit einer axialen Neigung zur Längsachse der Elektrode (10) erstrecken.

7. Vorrichtung nach Anspruch 6, dadurch gekennzeichnet, daß der Winkel der axialen Neigung der Leitungen (1) 1° bis 30° beträgt.

8. Vorrichtung nach Anspruch 7, dadurch gekennzeichnet, daß der Winkel der axialen Neigung der Leitungen (1) 5° bis 20° beträgt.

9. Vorrichtung nach Anspruch 6, 7 oder 8, dadurch gekennzeichnet, daß die axiale Neigung der Leitungen (1) in Richtung der Spitze der Elektrode (10) liegt.

10. Vorrichtung nach Anspruch 6, 7, 8 oder 9, dadurch gekennzeichnet, daß der Winkel der Leitungen (1) von der Tangentialen am Außenumfang des Dichtungsrings (15) 10° bis 170° beträgt.

11. Vorrichtung nach einem der Ansprüche 6 bis 10, dadurch gekennzeichnet, daß die Leitungen (1) mit einer Ringleitung (12) verbunden sind, die sich innerhalb oder auf dem Außenumfang des kühlenden Dichtungsrings (15) befindet.

12. Vorrichtung nach einem der Ansprüche 6 bis 11,

dadurch gekennzeichnet, daß die Leitungen über Öffnungen (13) teilkreisförmiger oder ovaler oder winkeliger Gestalt in den Spalt (11) münden.

Revendications

1. Procédé permettant de sceller l'intervalle compris entre une électrode de graphite et un orifice destiné à l'électrode passant à travers le couvercle d'un four électrique par l'utilisation d'un anneau de refroidissement et d'étanchéité constitué de matière réfractaire, caractérisé en ce qu'un mélange de gaz et de fluide est acheminé à l'intervalle (11) via une série de conduites (1) dans l'anneau de refroidissement et d'étanchéité (15) qui sont uniformément distribuées autour de la circonférence de l'anneau d'étanchéité (15) et s'étendent dans une direction ayant à la fois une composante radiale et une composante tangentielle conjointement avec une inclinaison axiale relativement à l'axe longitudinal de l'électrode (10), si bien que le mélange de gaz et de fluide joue le rôle de joint étanche et que le fluide absorbe la chaleur provenant de la région interne à l'anneau de refroidissement et d'étanchéité (15) par réaction endothermiques, vaporisation et/ou craquage.

2. Procédé selon la revendication 1, caractérisé en ce que le fluide est une huile, une graisse, un goudron, de l'eau ou un alcool.

3. Procédé selon la revendication 1 ou 2, caractérisé en ce que le gaz est de l'air, de la vapeur d'eau, du gaz naturel, du gaz de four de coke ou du gaz à l'eau, de l'azote, du monoxyde de carbone ou de l'anhydride carbonique.

4. Procédé selon la revendication 1, 2 ou 3, caractérisé en ce que le mélange de gaz et de fluide contient, en outre, des particules de poudre.

5. Procédé selon la revendication 4, caractérisé en ce que les particules de poudre sont des charbons volatils, par exemple de la lignite ou des charbons flambants gras.

6. Appareil permettant de sceller l'intervalle compris entre une électrode de graphite et un orifice destiné à l'électrode passant à travers le couvercle d'un four électrique, qui comprend un anneau de refroidissement et d'étanchéité constitué de matière réfractaire, caractérisé en ce que l'anneau de refroidissement et d'étanchéité (15) possède une série de conduites (1) uniformément distribuées autour de sa circonférence et débouchant dans l'intervalle (11) conduites (1) s'étendant à travers l'anneau de refroidissement et d'étanchéité (15) dans une direction ayant à la fois une composante radiale et une composante tangentielle conjointement avec une inclinaison axiale relativement à l'axe longitudinal de l'électrode (10).

7. Appareil selon la revendication 6, caractérisé en ce que l'angle d'inclinaison axiale des conduites (1) est de 1 à 30°.

8. Appareil selon la revendication 7, caractérisé en ce que l'angle d'inclinaison axiale des conduites (1) est de 5 à 20°.

9. Appareil selon la revendication 6, 7 ou 8, caractérisé en ce que l'inclinaison axiale des conduites (1) est en direction de la pointe de l'électrode (10).

10. Appareil selon la revendication 6, 7, 8 ou 9, caractérisé en ce que l'angle des conduites (1) à partir de la tangente sur la circonférence externe de l'anneau d'étanchéité (15) est de 10 à 170°.

11. Appareil selon l'une quelconque des revendications 6 à 10, caractérisé en ce que les conduites (1) sont connectées à une conduite annulaire (12) qui se trouve sur la circonférence interne ou externe de l'anneau de refroidissement et d'étanchéité (15).

12. Appareil selon l'une quelconque des revendications 6 à 11, caractérisé en ce que les conduites débouchent dans l'intervalle (11) via des ouvertures (13) de forme partiellement circulaire, ovale ou angulaire.

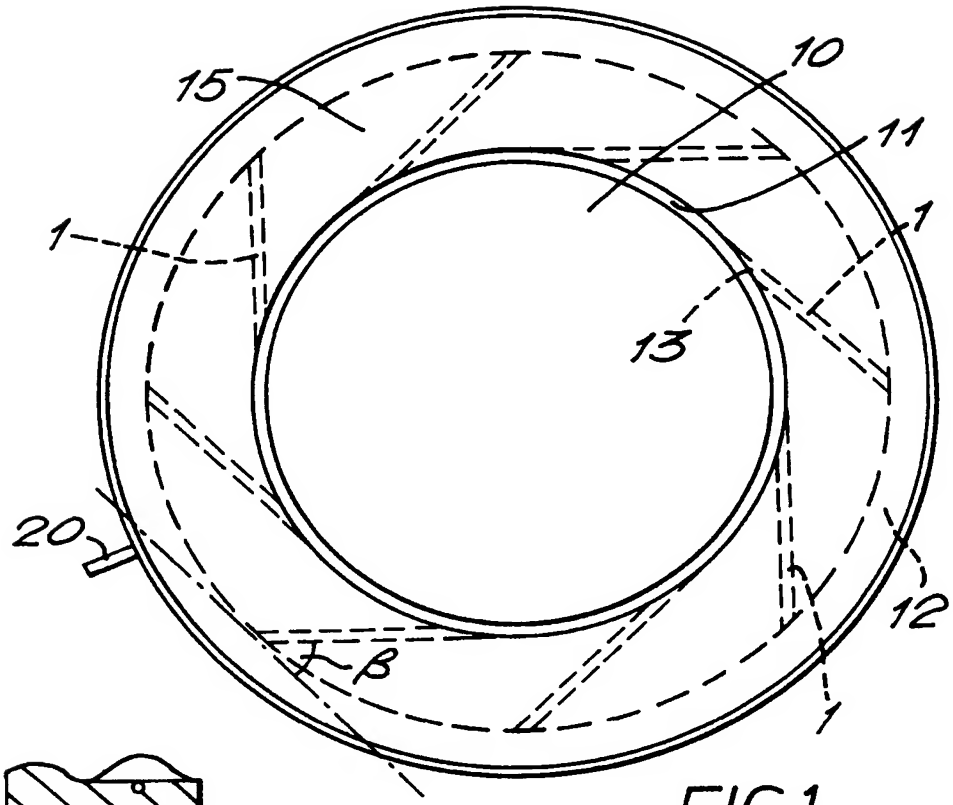

FIG.1.

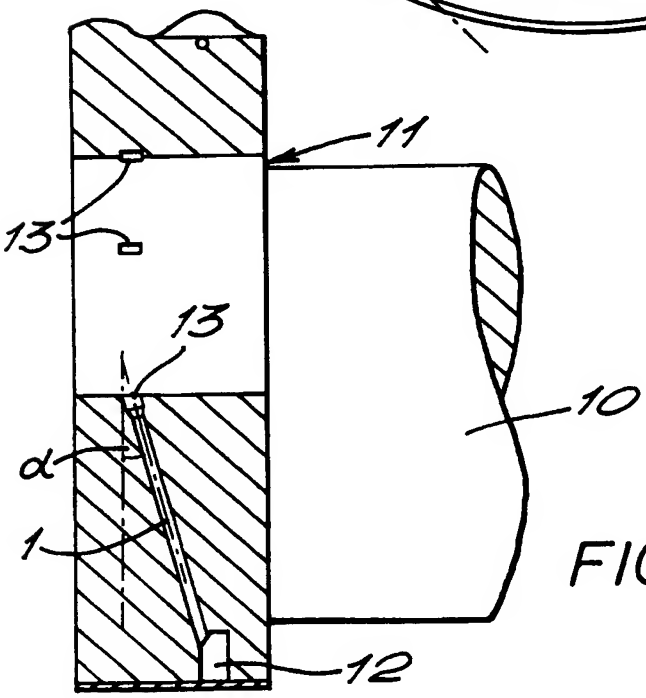

FIG.2.